

APPENDIX C
PROPOSED OPERATION RULE

Folsom Dam Modification

Operation Plan to Minimize Impact of Larger Outlets On American River Flows

Background: The Folsom Dam gated outlet capacity is limited to 33,000 cfs +/- when the reservoir pool is below elevation 418' (509,000 acre-feet storage = 466,000 acre-feet space). The current flood space ranges from 400,000 acre-feet space (elevation 426') to a maximum of 675,000 acre-feet space (elevation 388'). The inability of Folsom Dam to release more than 33,000-cfs +/- when the pool is below elevation 418' is the major constraint on the dam's capability to provide flood protection for Sacramento. The Folsom Modification Project corrects this deficiency by increasing the outlet capacity through enlarging the outlets and providing the capability to release the downstream channel capacity (115,000 cfs) at elevation 418'.

Concerns: The potential for increased downstream channel scour and transport of gravel in the American River downstream of Folsom Dam due to the more frequent occurrence of high flows has been raised as an issue for the Folsom Dam Modification Project. The concern is that for relative frequent flood events (2 to 10-year average exceedance intervals) the changed outlet capacity at Folsom Dam will result in greater flows downstream. These greater flows may increase gravel transport and have consequent environmental impacts.

Study Scope: This paper presents the results of studies to investigate the potential for increased flows, an evaluation of the expected impact of Folsom Modification on downstream flows for different magnitude flood events and an analysis of operational mitigation opportunities for all identified impacts.

Study: An analysis of the operation of Folsom Dam from 1955 through present was conducted. This analysis included all of the Folsom Dam outflows as measured by the U.S.G.S. gage at Fair Oaks. This historic operation includes the impact of the restricted outlet capacity of 33,000 cfs, drought and wet cycles and the conservation operation of the project.

Chart 1 displays the results of the analysis. The annual maximum flow for the American River at Fair Oaks (1955 through present) is plotted against probability of exceedance. The plot shows that for floods smaller than the 2-year flood (50% of all the years) the outflow never reached 30,000 cfs. Therefore, for all of those floods an increased outlet capacity would not have resulted in any change in flows along the American River. It is noted that the maximum hydroelectric power release at Folsom Dam is 8,000 cfs and any flow greater than 8,000 cfs is considered to be a significant flood release. In 21 of the 45 years the outflow from Folsom Dam did not exceed 8,000 cfs.

Since 1955 only four floods have resulted in outflows over 100,000 cfs (10-year exceedance interval). Therefore, for floods larger than a 10-year flood the new outlets will not result in greater flows in the American River since the objective downstream flow is 115,000 cfs and this level of outflow was reached under historical operation. The Folsom Modification Project increases flood protection for Sacramento by reducing American River flows for floods greater than the 85-year flood. Folsom outflows for floods that are larger than the 10 year flood but smaller than the 85 year flood will not change as a result of Folsom Modifications. The analysis of the historic operation shows that the range of floods that the Folsom Modification could increase flows is between the 2.5-year flood and the 10-year flood. In the historic record 13 of the 45 maximum annual floods (approximately 30% of all of the maximum annual floods) were included in this range.

In order to estimate the potential for increased flows in the American River the magnitude of the inflow to Folsom Dam must be considered. It is evident that the outflows will not exceed peak inflow for any flood regardless of the outlet capacity. Using the record since 1905 the Folsom Reservoir Peak inflow frequency curve was computed and is plotted on chart 1. This curve provides the upper bound for outflows. In actual operation the outflow is always less than the maximum inflow because as soon as the inflow is forecast to decline for these relatively small floods (2.5-year to 10-year) the dam operators stop increasing outflows. The rate of increase in reservoir storage and the rate of increase in the reservoir inflow both play a role in determining the maximum outflow for a given flood event. Considering all of these factors the outflow frequency curve for unrestricted release with Folsom Modifications in place is shown on Chart 1. The Folsom Modification outflow frequency curve was compared with the historic outflow data. The American River flows for floods between 2.5-year and 10-year exceedance flood levels could potentially be increased by the modification of Folsom Dam. The greatest increase (up to 40%) would occur between the 2.5-year and 5-year flood levels if maximum flood releases were made.

Mitigation: It is unknown at this time if the potential for increased flows for a relative small number of floods (less than 13 floods since 1955) for which the duration lasted about 1 day would create an increased problem with spawning gravel in the Lower American River. For the purpose of this analysis it was assumed that the changes in the flow regime were significant and must be mitigated.

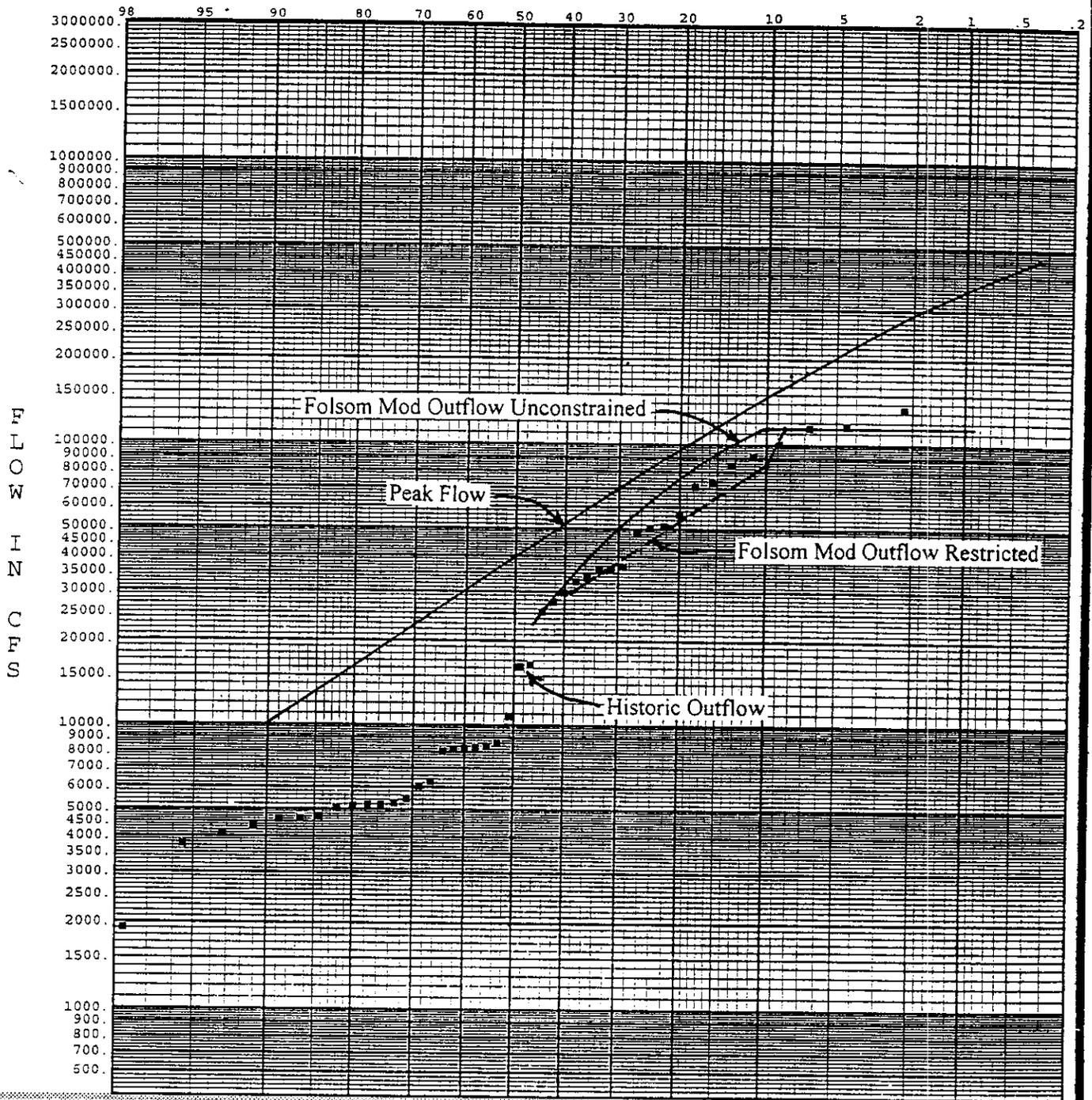
Since the presumed impact of the Folsom Modification would be confined to relatively small floods, an operational "Rule Restriction" was adopted as a mitigation method. The concept of the "Rule Restriction" is to limit the Folsom Modification outlet releases to less than historic levels for the critical range of flows between the 2.5-year and the 10-year flood exceedance level without restricting outflows during design floods. The following Rule was developed:

Outflows from Folsom Dam above 25,000 cfs will be limited to 60% of the actual or forecast inflow. Once the actual or forecast inflow exceeds 150,000 cfs maximum flood releases will be made.

This Rule impacts floods smaller than the 10-year exceedance flood (145,000 cfs). The 5-year and 10-year floods were routed through Folsom dam to estimate the impact of the proposed Rule. Charts 1 & 2 display the results of the flood routing. Chart 2 compares the 5-year and 10-year flood routings. The proposed Rule would limit the 5-year flood outflow from Folsom Dam to 46,000 cfs. The 10-year flood would be limited to 57,000 cfs. The 2.5-year flood (40% chance exceedance) would be limited to 30,000 cfs. Chart 1 displays the estimated flow frequency of the proposed Rule operation. The proposed rule would not impact Folsom Dam outflows for floods larger than the 10-year flood because the criteria limit only applies to inflows less than 150,000 cfs. The proposed Rule would not limit flood releases for the 100-year flood (peak inflow over 300,000 cfs) for example.

Conclusion: The Modification of the Folsom Dam outlets to increase the flood discharge capacity at Folsom Dam could result in an increase in American River flows for a relative small number of floods for a duration of about one day. Comparing the potential outflows with the historic record, about 13 flood events were identified that would have been affected by the Folsom Modifications Project. It is unknown if this potential flow increase would be a significant impact at this time. An operating Rule was developed to mitigate any potential impacts due to increased flows in the American River. The Rule would limit Folsom outflows to 60% of inflow unless the forecast or actual inflow exceeded 150,000 cfs. Regardless of the need to mitigate increased flows in the American River the proposed Rule would be a useful guide in operating Folsom Dam. The Folsom Modification Project would substantially change the capability of Folsom Dam to release extremely high flows without operating the spillway. The proposed Rule would act as a check against making unnecessarily high releases to the lower American River.

EXCEEDANCE FREQUENCY IN PERCENT

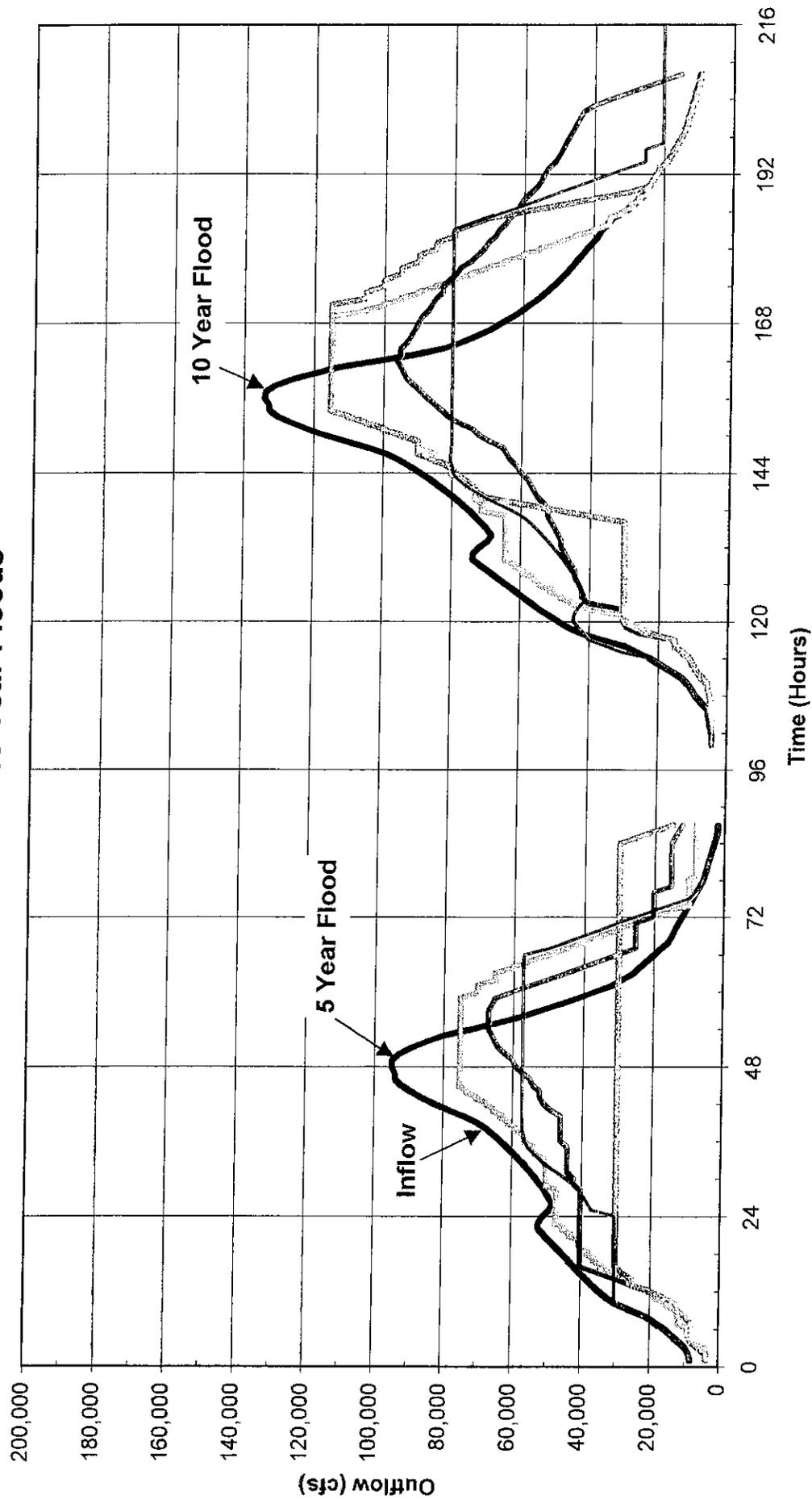


American River at Fair Oaks

60% Rule Curve

Folsom Modification Impacts

American River - Folsom Modification Impacts 5 Year and 10 Year Floods



- Inflow
- Existing Outlets - 200k U/S Stor. Avail.
- Restricted Folsom Mod - 60% Inflow Rule
- Unrestricted Folsom Mod